

# ***Health Consultation***

## **B & L Woodwaste Landfill Tacoma, Pierce County, Washington**

August 28, 2001

**Prepared by  
Washington State Department of Health  
Under Cooperative Agreement with the  
Agency for Toxic Substances and Disease Registry**



## Foreword

The Washington State Department of Health (DOH) has prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services, Public Health Service. The mission of ATSDR is to prevent or mitigate adverse human health effects and diminished quality of life resulting from exposure to hazardous substances in the environment. This health consultation was prepared in accordance with ATSDR methodology and guidelines.

Health consultations provide advice on specific public health issues which may occur as a result of an actual, or a potential human exposure to a hazardous material. Health consultations represent a response to a specific question or a request for health information pertaining to a hazardous substance or hazardous waste sites. Health consultations often contain a time-critical element necessitating a rapid response, and therefore, represent a more limited response than a traditional public health assessment.

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## Glossary

<b>Agency for Toxic Substances and Disease Registry (ATSDR)</b>	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
<b>Aquifer</b>	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
<b>Cancer Risk Evaluation Guide (CREG)</b>	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
<b>Cancer Slope Factor</b>	A number assigned to a cancer causing chemical that is used to estimate it's ability to cause cancer in humans.
<b>Carcinogen</b>	Any substance that can cause or contribute to the production of cancer.
<b>Chronic</b>	A long period of time. A chronic exposure is one which lasts for a year or longer.
<b>Comparison value</b>	A concentration of a chemical in soil, air or water that, if exceeded, requires further evaluation as a contaminant of potential health concern. The terms comparison value and screening level are often used synonymously.
<b>Contaminant</b>	Any chemical that exists in the environment or living organisms that is not normally found there.

<b>Dose</b>	A dose is the amount of a substance that gets into the body through ingestion, skin absorption or inhalation. It is calculated per kilogram of body weight per day.
<b>Environmental Media Evaluation Guide (EMEG)</b>	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on ATSDR's <i>minimal risk level</i> (MRL).
<b>Exposure</b>	Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long term (chronic).
<b>Groundwater</b>	Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.
<b>Hazardous substance</b>	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
<b>Indeterminate public health hazard</b>	Sites for which no conclusions about public health hazard can be made because data are lacking.
<b>Ingestion rate</b>	The amount of an environmental medium which could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
<b>Inorganic</b>	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.

<b>Lowest Observed Adverse Effect Level (LOAEL)</b>	LOAEL's have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.
<b>Maximum Contaminant Level (MCL)</b>	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
<b>Media</b>	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
<b>Minimal Risk Level (MRL)</b>	An amount of chemical that gets into the body (i.e. dose) below which health effects are not expected. MRLs are derived by ATSDR for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.
<b>Monitoring wells</b>	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
<b>No apparent public health hazard</b>	Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.
<b>No Observed Adverse Effect Level (NOAEL)</b>	The dose of a chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be observed at this dose but were judged not to be "adverse".

<b>Oral Reference Dose (RfD)</b>	An amount of chemical ingested into the body (i.e. dose) below which health effects are not expected. RfDs are published by EPA.
<b>Organic</b>	Compounds composed of carbon, including materials such as solvents, oils, and pesticides which are not easily dissolved in water.
<b>Parts per billion (ppb)/Parts per million (ppm)</b>	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
<b>Recharge</b>	The process by which water is added to a zone of saturation, usually by percolation from the soil surface, e.g., the recharge of an aquifer.
<b>Reference Dose Media Evaluation Guide (RMEG)</b>	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
<b>Remedial investigation</b>	A study designed to collect the data necessary to determine the nature and extent of contamination at a site.
<b>U.S. Environmental Protection Agency (EPA)</b>	Established in 1970 to bring together parts of various government agencies involved with the control of pollution.

## Background

The Washington State Department of Health (DOH) prepared this health consultation in response to a request from the Department of Ecology (Ecology) to evaluate the potential for human exposure to wood waste contamination associated with the B&L Landfill (B&L) site located in Pierce County, Washington. The primary concern is whether or not off-site groundwater is being impacted by the B&L site. This health consultation is limited to an evaluation of the B&L site and does not represent an area-wide evaluation of the potential for exposure to wood waste contamination.

The B&L site is approximately 20 acres in size and located 1.5 miles southeast of the Hylebos waterway in Milton, Washington.<sup>1</sup> The site is located within a mixed residential, agricultural, and commercial area near the Pierce/King county border within the original boundary of the Puyallup Indian Reservation.<sup>2</sup> The site is surrounded by Fife Way to the southeast, a Puget Power access road and wetland directly north, an apartment complex southeast, and active agricultural land located southwest and west of the site. Municipalities surrounding the site include Federal Way to the north, Milton to the east, unincorporated Pierce County to the south, and Fife/Tacoma to the west (Figure 1). In 1999, the estimated population of Pierce County was approximately 700,000 and the total population of Milton was estimated to be 4,785.<sup>3</sup> The population within a one-mile radius of the B&L site is 4,015 (Figure 2).<sup>4</sup>

The B&L landfill operated from the mid-1970s through 1981, receiving debris from log sort yards located within the Commencement Bay Nearshore/Tideflats (CBN/T) Superfund site. The landfill reportedly received 250,000 cubic yards of waste material from log sorting yards.<sup>2</sup> The debris consisted of primarily bark wood waste, gravel, sandy and silty soils from log sorting yards, and American Smelting and Refining Company (ASARCO) slag (a byproduct of copper ore smelting). Slag typically contains about one percent arsenic and other heavy metals.<sup>5</sup> An unknown amount of baghouse dust from the ASARCO smelter and approximately 6,000 gallons of bentonite slurry were also disposed of at the landfill site.<sup>1</sup> In addition, approximately 1,000 cubic yards of shredded car debris and an unknown amount of materials from USG interiors were disposed of on-site. The B&L landfill site was closed as a disposal site in January 1981, but continued to accept clean fill through October 1989.<sup>5</sup> The landfill was identified as a contributing source of heavy metals (primarily arsenic) to the Hylebos creek, and ultimately into the Hylebos waterway of the CBN/T Superfund site.<sup>1</sup>

A cleanup action plan for the B&L site was completed in October 1991. The cleanup plan outlined a selected remedy for site cleanup consisting of: consolidating the landfill from 18.5 to 13 acres, creating a landfill cap, controlling storm water, excavating ditch sediments, implementing surface water controls, institutional controls including erecting a fence around the landfill, and groundwater and surface water monitoring. By the end of 1992, the site was stabilized and landfill consolidation was completed. Remediation activities at the B&L site were completed in 1993, and the landfill was capped in 1994.

The ASARCO Smelter operated in the Commencement Bay area from the late 1800s until 1985.

ASARCO provided significant amounts of slag (containing metals such as arsenic, cadmium, copper, lead, mercury, nickel, zinc, and antimony) which were used throughout the CBN/T area as fill, riprap, ballast, and sandblasting grit.<sup>1</sup> Log sorting yards used slag from the ASARCO smelter as ballast to stabilize ground used by heavy equipment and log-hauling trucks.

Previous groundwater investigations indicate three distinct aquifers exist under the landfill site: fill aquifer (landfill), sand aquifer (upper zone), and sand aquifer (lower zone). The fill aquifer and sand aquifer are separated by a silty topsoil deposit called the upper silt aquitard. The sand aquifers are separated by a silty deposit called the lower aquitard. Groundwater flow direction in the fill and sand aquifers is northwest towards a wetland. Groundwater concentrations of arsenic in the fill aquifer are as high as 140 parts per million (ppm). Elevated levels of metals such as arsenic, copper, chromium, lead, and zinc have been identified in the sand aquifer. Upward movement of groundwater keeps contaminants primarily in the upper zone of the sand aquifer.<sup>1</sup>

During March 1987 four monitoring wells were installed on-site (EE19-EE22). An additional monitoring well (EE23) was constructed 300 feet off-site between the northeast corner of the landfill and the City of Milton municipal well #3. The general groundwater flow direction in the area of the landfill is north-northwest (Figure 3), but is affected by seasonal variation.<sup>1</sup> During the spring, groundwater flow direction shifts westward due to runoff recharge from the upland area located east of the site. In the summer and fall, groundwater flow direction is more northward (toward the wetland) as a result of less recharge.<sup>6</sup>

During the fall of 1998, five shallow monitoring wells were completed north of the landfill in a wetland located down gradient of the site. The monitoring wells (MW-13 through MW-17) have been sampled quarterly since 1998 (Figure 4). Groundwater flow direction within the wetland varies seasonally.

Groundwater in the vicinity of the B&L site is used for municipal and domestic drinking water supplies, and is also used for irrigation purposes. Human exposure to potentially contaminated groundwater depends upon use of contaminated wells. There are presently 13 public supply wells within a one-mile radius of the B&L site. The nearest public supply well is a City of Milton municipal well (source #1/well #3) located within 750 feet northeast of the site (Figure 5).<sup>5</sup> The City of Milton also has 3 additional supply wells located approximately one-half mile northeast of the landfill (source #2, #3, and #4). All City of Milton public water system sources are located hydraulically up gradient of the site.<sup>5</sup> The City of Fife has five municipal supply wells located approximately one mile west of the site across Interstate 5. Municipal wells have been regularly monitored in accordance with federal Safe Drinking Water Act requirements to ensure they are not being impacted by the landfill.

Private wells located in the vicinity of the landfill are used for domestic supply and irrigation. During 1987, private wells within a one-mile radius of the site were sampled, and a limited amount of private well sampling was conducted in 1992 and during May of 2000. Currently, the number of private wells in use located within a one-mile radius of the site is unknown. Refer to Appendix A (Figure 6) for a distribution of known private wells in use in the vicinity of the site.



The landfill site has five sides and rises above the Puyallup River valley floor 20 - 30 feet above mean sea level (Figure 4).<sup>6</sup> The perimeter of the site is secured by a six-foot chain-link/barbed wire fence. Therefore, direct contact with contaminated on-site soils is not expected to occur unless it is associated with runoff from the site into areas extending beyond the perimeter of the site fence line. However, there is potential for off-site migration of metals into ditches surrounding the site. Contaminants may drain off-site via surface water and be deposited in ditch systems around the site.

A site visit was conducted at the B&L landfill by Trace Warner of DOH, Dom Reale (Ecology site manager) and Anne Boeholt (Ecology wetlands specialist). Photos taken during the site visit are listed in Appendix A (Figure 7). During the site visit, it was noted that a residence is located within approximately 100 feet of the southern boundary of the site (Figure 4).

### *Environmental Sampling*

#### ► On-site Groundwater

Four on-site monitoring wells (EE19-EE22) were installed within the perimeter fence line at the B&L site during March 1987. An additional monitoring well (EE23) was installed approximately 300 feet northeast of the landfill between the site boundary and the City of Milton public well #3. Groundwater samples collected from the monitoring wells in 1987 indicated the highest concentration of arsenic at 38.0 ppm (EE20); antimony 0.15 ppm (EE22); cadmium 0.26 ppm (EE21); lead 0.12 ppm (EE20); nickel 0.094 ppm (EE22); and zinc 1.17 ppm (EE22).

During August 1989 six monitoring wells (D1L, D1U, D3L, D3U, D4U and D4L) were installed on-site. Also, between October and November of 1993, ten monitoring wells were installed on-site: D6A, D6B, D7A, D7B, D8A, D8B, D9A, D10A, D11A, and D11B. Refer to Appendix B (Table 3) for screening depths of monitoring wells installed at the B&L site.

#### ► Off-site Contamination

Five additional monitoring wells (MW13 - MW17) were installed in a wetland north of the site in the fall of 1998. Concentrations of arsenic detected in the wetland monitoring wells were as high as 6.2 ppm (MW-13) collected on March 24, 2000, which is 120 times the federal drinking water standard of 0.05 ppm. The highest concentration of arsenic in a monitoring well other than MW13 was 3.4 ppm (MW-15) collected September 14, 1999.

Previous investigations of the B&L landfill site indicate the primary source of arsenic contamination in on-site groundwater is slag contained in wood waste fill material. The extent of arsenic contamination in shallow off-site groundwater has not been completely characterized.

#### ► Surface Water

A series of drainage ditches surround the B&L landfill and converge at the northwest corner of the site into a single ditch (B&L landfill ditch).<sup>7</sup> The ditch drains into the Surprise Lake drain,

which connects to the Hylebos Creek, and ultimately empties into the Hylebos Waterway of Commencement Bay. During winter months, when the water table is near ground surface, seepage from the landfill into perimeter ditches has been observed.<sup>8</sup> Concentrations of arsenic as high as 3.4 ppm have been detected in surface water.

► Municipal Wells

Nine (Group A) public supply wells are located within a one-mile radius of the B&L landfill site. There are four (Group B) public supply wells within a one-mile radius of the site.<sup>a</sup> The City of Milton presently has four active public water supply wells serving an estimated population of 8,000; and the City of Fife has five active supply wells serving an estimated population of 5,000. City of Fife well #3 had an arsenic detection of 21 parts per billion (ppb) in May 1992 and reported a level of 20 ppb arsenic in May 2000. In addition, arsenic was found in Fife well #6 at 13 ppb in June 1997 and at 10 ppb in well #6 and well #5 in May 2000.

Fife well #3 is used only as an emergency supply source while Fife well #6 and well #5 are permanent sources used to supply municipal drinking water. Both these wells are downgradient of the B&L landfill with well #6 being the closest of the two. Although arsenic is present in municipal water supplied by the City of Fife, exposure of consumers is difficult to quantify. Factors to consider when estimating exposure include well use and dilution by uncontaminated wells. Other slag constituents have not been detected in municipal wells.

► Private Wells

The majority of the private wells located near the B&L landfill are believed to be used for domestic and irrigation purposes. In March 1987, thirty seven private wells were sampled by EPA. The private wells were sampled for cyanide and inorganic chemicals on the EPA target compound list. None of the contaminants detected in private wells during the 1987 sampling event exceeded primary drinking water standards. One private well located northwest of the landfill contained arsenic at 24 ppb. A few of the private wells exceeded secondary drinking water standards for sodium and iron. Secondary drinking water standards are established for taste, odor, and aesthetic considerations.

In May 1992, a limited residential sampling of private wells was also conducted (7 private wells). The wells were monitored for arsenic, lead, and nickel. The highest concentration of arsenic was detected in a well south of the site (21 ppb). The same wells were also sampled in May of 2000, but were only monitored for arsenic. The highest concentration of arsenic detected in this sampling event was also 21 ppb in the same well as the 1992 sampling event. A single sample result (analyzed in March 2000), obtained from a private well owner with a well located south of the site, indicated a concentration of 31 ppb arsenic.

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<sup>a</sup> A “Group A” public water system is defined as a system that regularly serves 15 or more residential connections or 25 or more people per day for at least 60 days per year. A “Group B” public water system is defined as a system serves between 2 and 14 residential connections. Group A wells are subject to more stringent testing requirements.

Individual households relying upon shallow private wells in the vicinity of the B&L landfill may be exposed to arsenic contaminated groundwater at levels approaching the current drinking water standard. Although the highest concentration of arsenic detected in a private well near the site was 31 ppb, the extent of arsenic contamination in the shallow aquifer off-site is not well characterized. Therefore, it is not clear if the 31 ppb is representative of the maximum levels of arsenic present in shallow off-site groundwater surrounding the site.

## **Discussion**

Slag contained in wood waste has been identified as the primary source of arsenic in groundwater at the B&L site. Arsenic-contaminated groundwater has been continually documented north of the site in the wetland and concentrations increase in wells located closer to the site.

Contaminants of concern for the B&L site were selected based upon limited environmental sampling data. Contaminants of concern were determined and evaluated by comparing concentrations of contaminants (in groundwater) to ATSDR comparison (screening) values. Contaminants of concern for the B&L site are listed in Appendix B (Tables 1 and 2). Although some contaminants of concern that are included in Appendix B, Tables 1 and 2, are reported as not-detected, they are included as contaminants of concern because they have not been adequately sampled and analyzed for since 1987. If a contaminant exceeds a comparison value in any single environmental medium, it is considered to be a contaminant of concern, and evaluated further in all site-specific environmental media. Contaminants of concern may not actually represent a public health hazard, but are evaluated further using health-based guidelines.

In order to assess potential health effects that could result from exposure to site contaminants, a daily dose is calculated for exposed individuals. The estimation of the daily exposure dose involves determining contaminant concentrations at points of potential human exposure and developing site-specific exposure assumptions regarding the extent of human exposure. For this evaluation, maximum concentrations of contaminants of concern present in off-site groundwater are considered to be representative of potential human exposure. Residential exposure scenario assumptions for the groundwater pathway are listed in Appendix D.

### *Evaluating non-cancer endpoints*

After considering site-specific factors, exposure dose estimates are compared to health-based guidelines. ATSDR Minimum Risk Levels (MRLs) or Environmental Protection Agency (EPA) oral Reference Doses (RfDs) are compared to exposure dose estimates to determine if adverse health effects are likely to occur from exposure to contaminant concentrations present in groundwater. MRLs are estimates of daily human exposure to a chemical that is not likely to result in non-cancer adverse health effects over a specified duration of exposure. MRLs are derived by ATSDR, and are based upon systemic non-carcinogenic health effects. A comparison of estimated exposure doses to MRLs, RfDs, and other information, allows for evaluation of

potential health effects that may result from exposure to contaminated groundwater.

Exposures greater than the MRL will not necessarily result in adverse health effects. When the calculated dose is above the MRL, available epidemiologic and toxicologic data are evaluated to determine the potential for adverse health effects. If an MRL is not available, an RfD is used. RfDs are derived by EPA, and represent estimates of daily exposure to a chemical that are not likely to result in adverse non-carcinogenic health effects. If the calculated exposure dose is below the MRL, the conclusion is usually that non-cancer health effects are not likely. *It is important to note that simply because a calculated exposure dose exceeds an MRL a health threat does not necessarily exist.*

If an estimated daily exposure dose exceeds an MRL or RfD, the dose is compared to No Observed Adverse Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs) from various animal, and if available, human studies to determine if health effects are likely to occur from a specific exposure dose. The LOAEL represents the lowest dose at which an adverse health effect is observed, and the NOAEL represents the highest dose that did not result in an adverse health effect.

#### *Evaluating cancer risk*

The potential for chemicals to cause cancer is evaluated in a different manner than for non-cancer effects. EPA reviews available data from human and animal studies to determine the carcinogenic potential of specific chemicals. For many of these chemicals, a cancer potency factor (also known as a slope factor) has been derived that can be used with the estimated daily exposure dose to predict the increased risk of an individual developing cancer over a lifetime of 70 years.

Cancer risk estimates are not *yes/no* answers, but measures of chance (probability) that are based on extrapolation from animal or human studies. This extrapolation assumes that there is “no safe dose” of any cancer-causing chemicals. The validity of this assumption is not clear, as some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold before initiating cancer. Although considerable uncertainty exists regarding cancer risk estimates made here, such measures are useful in determining the magnitude of a cancer threat.

#### *Public Health Implications*

A worst case exposure scenario was evaluated for adults and children using off-site groundwater from municipal and domestic wells. Constituents associated with slag were analyzed during the

<b><u>Cancer Risk</u></b>		
Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a population over a lifetime:		
<u>Term</u>		<u># of Excess Cancers</u>
high	is approximately equal to	1 in 100
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000

private well sampling event in 1987. However, the private well sampling event in 1992 analyzed samples for only for arsenic, lead, and nickel. The subsequent sampling event conducted in May 2000 only included analysis of arsenic. Without actual contaminant data indicating the concentration of cadmium, copper, lead, mercury, nickel, zinc, and antimony, it was not possible to estimate exposure doses for these constituents for individuals using private wells within a one-mile radius of the landfill site. The available data indicates that slag-related constituents other than arsenic are not impacting municipal wells.

### Arsenic

Arsenic occurs naturally in rock, soil, water, air, and plants. It can be distributed and concentrated in the environment through natural processes such as volcanic action, erosion of rock, or by human activities. It is important to distinguish between organic and inorganic arsenic, as the inorganic form is more toxic. Natural mineral deposits in certain areas of the state of Washington contain large quantities of arsenic which may result in elevated levels of inorganic arsenic in groundwater. People who are exposed to too much arsenic in their environment, whether from natural processes or from human activities, can develop health problems.

Ingestion of inorganic arsenic has been reported to cause more than 30 different adverse health effects in humans, including cardiovascular disease, diabetes mellitus, skin changes, damage to the nervous system, and various forms of cancer. Numerous epidemiologic (human) studies of large numbers of people in several areas of the world have found strong associations between arsenic exposure in drinking water and cancer of the lung, bladder, or skin. The single large-scale study of the effects of arsenic-contaminated drinking water on a U.S. population did not demonstrate an association between ingestion of inorganic arsenic in drinking water and cancer, although hypertensive heart disease appeared elevated in the exposed group.<sup>8</sup> Differences among the studies in degree of exposure, sensitivity of the populations to the effects of arsenic, or statistical power could account for the failure to detect an association with cancer in the U.S. population.

EPA has set a regulatory limit on the amount of arsenic allowed in public drinking water systems. This limit, 50 ppb, is called the Maximum Contaminant Level (MCL). To better protect public health, EPA set a lower MCL (10 ppb) in January 2001. However, due to concerns of increased cost (an MCL is not strictly health-based, but must consider costs of compliance), this lower MCL was rescinded while further study is conducted (Refer to Appendix C for a more detailed discussion of the arsenic drinking water standard revision). It should be noted that there is less than 10-fold difference between the arsenic dose at the current MCL and the dose at which cancer and non-cancer health effects have been observed in people. In contrast, the MCLs for most other cancer-causing chemicals are set more than 1,000-fold less than the doses found to cause health effects.

The highest concentration of arsenic detected in a groundwater sample (31 ppb) was identified in a private well located south of the B&L site. The highest concentration of arsenic detected in a public water system well (21 ppb) was City of Fife well #3 in June 1992. The estimated exposure

dose for a child drinking 31 ppb arsenic in drinking water is 0.0028 mg/kg/day based on a body weight of 16 kg and an ingestion rate of 1.5 liters of water per day. ATSDR has developed an oral MRL for inorganic arsenic of 0.0003 mg/kg/day for chronic exposure.<sup>9</sup> The estimated daily exposure dose calculated for a child ingesting 31 ppb arsenic contaminated groundwater on a daily basis is approximately 10-fold greater than the ATSDR chronic oral MRL. Exposure to arsenic may have occurred in the past, may be currently occurring, or may occur in the future for individuals using private wells as a primary source of drinking water.

In order to further evaluate possible health effects, estimated long-term daily exposure doses were compared to the No Observed Adverse Effect Level (NOAEL) of 0.0008 mg/kg/day and the widely used Lowest Observed Adverse Effect Level (LOAEL) of 0.014 mg/kg/day in humans from which the MRL was derived.<sup>9</sup> Estimated daily exposure doses of a child ingesting the maximum concentration of arsenic detected in private wells is approximately three times greater than the NOAEL, but five times less than the LOAEL. Adverse health effects observed at or near this chronic LOAEL include skin cancer, non-cancer changes in the skin, vascular disease, and liver enlargement. Less serious effects were also observed in humans near this LOAEL of 0.014 mg/kg/day and included gastrointestinal irritation such as nausea, vomiting, and diarrhea.

EPA has classified arsenic as a known human carcinogen and developed an oral cancer slope factor of 1.5 mg/kg/day to estimate the risk of skin cancer resulting from arsenic exposure.<sup>10</sup> Although this number has been questioned, a recent evaluation by EPA suggests that this number may give a good estimate of combined cancer risk (including bladder and lung) from arsenic when the exposure is close to the dose expected from drinking water at the MCL. *Arsenic concentrations at the MCL are estimated to result in a moderate increase in cancer risk, about one cancer expected for 1000 persons exposed over many years.*

#### *ATSDR Child Health Initiative - Exposure Pathways and Children*

ATSDR and DOH recognize the unique vulnerability of infants and children, and that they require site-specific evaluation regarding exposure to environmental contaminants. Infants, children, and developing fetuses may be at greater risk for potential exposure and adverse health effects compared to older children or adults. Children are more likely to engage in outdoor activities which put them into direct contact with contaminants in soil. Frequent hand-to-mouth activities account for increased exposure in young children via ingestion and dermal contact.

Pound-for-pound body weight, children drink more water, eat more food, and breathe more air than adults. Children within the first six months drink seven times as much water (per pound) than the average adult.<sup>10</sup> As a result, because of the unique characteristics of children, given the same level of exposure, children receive a significantly higher contaminant dose than adults. For the purposes of this health consultation, children are defined as “the period from conception to maturity at 18 years of age, when all biological systems have matured.”

Cancer is the main health effect of concern associated with arsenic exposure in drinking water.

This assessment assumed that a child could be exposed from birth through thirty years of age to the maximum level of arsenic detected in private drinking water wells. This approach addresses the higher consumption of drinking water per body weight of children versus adults and so, is considered protective of both children and adults.

## Conclusions

1. Arsenic detected in private drinking water wells near the B&L landfill site *represents a public health hazard*.<sup>b</sup> Individual households relying upon shallow private drinking water wells in the vicinity of the B&L landfill have been exposed to arsenic contaminated groundwater that is associated with a moderate increase in excess lifetime cancer risk. The highest concentration of inorganic arsenic detected in a private well was 31 ppb.
2. Arsenic detected in public drinking water supply wells maintained by the City of Fife *represents an indeterminate public health hazard*. The most recent sampling of area public supply wells in May 2000 found 20 ppb arsenic in Fife well #3 and 10 ppb in Fife wells #5 and #6. Arsenic has not been found in any public wells maintained by the City of Milton. At the time these samples were collected, the arsenic levels did not exceed the current MCL of 50 ppb. However, because of the reliance on cost and the low margin of safety for the arsenic MCL, it may not be the best reference value to evaluate health risk from arsenic exposure. Assessing arsenic exposure for consumers of Fife public drinking water is complicated by source blending. Sampling and analysis for arsenic of blended water from the Fife system is required to better assess exposure.
3. Private well sampling in the area near the B&L landfill has been limited and did not always include analysis for slag-related constituents other than arsenic. Without private well sampling results indicating the concentrations of other slag related constituents such as antimony, cadmium, copper, lead, mercury, and zinc, it is not possible to evaluate exposure to these contaminants. In addition, there may be private wells not yet identified that may be impacted by slag-related landfill contamination.
4. Slag-related contamination has been documented in on-site and off-site groundwater. However, monitoring wells indicate that contaminants have migrated off-site in a manner that is not consistent with the suggested north/northwest groundwater flow direction. Current groundwater flow direction and the connection between the aquifers beneath the landfill is not well understood. Additional monitoring of groundwater is needed to further characterize the nature and extent of contaminants in groundwater near the B&L site. This monitoring should clarify the potential connection between the B&L site and arsenic found in nearby private wells.

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<sup>b</sup> Refer to Appendix E for definitions of public health hazard conclusion categories.

5. If the B&L site is proposed for a land use that allows for public access, the site will require further evaluation to determine the potential public health implications of any proposed change in land use.

### **Recommendations/Public Health Action Plan**

1. The potential for exposure to arsenic in private drinking water wells near the B&L Landfill needs to be further characterized. The number and construction details of private wells within a one-mile radius of the B&L landfill site should be determined. DOH will coordinate with the Tacoma-Pierce County Health Department and Ecology to develop a sampling plan to further characterize exposure to arsenic in private drinking water wells.
2. Further investigation is needed to characterize the vertical and lateral extent of groundwater flow within a one-half mile radius surrounding the site. As additional environmental data becomes available DOH will evaluate the B&L site for necessary follow-up health activities using current environmental data. DOH will coordinate with Ecology (lead oversight responsibility for the site) to obtain and evaluate data to further characterize the extent of contamination at the B&L site.
3. Both Group A and B public water system wells located within a one-mile radius of the site should continue to be monitored for slag related constituents. Drinking water supplied by the City of Fife well #6 should be monitored at different times of the year for arsenic to better determine the level of exposure to consumers. More frequent monitoring will help determine seasonal variability of arsenic levels. If possible, samples of blended water from the Fife system should also be collected and analyzed for arsenic.
4. If wells at homes located within 100 feet of the landfill will never be used, they should be abandoned in accordance with Ecology WAC 173-160-402 through 173-160-465.
5. Additional environmental monitoring data collected at the B & L site should be provided to DOH Office of Environmental Health Assessment, Site Assessment Section for review. The monitoring data should be provided in a hard copy and electronic file format to expedite review and evaluation. DOH will evaluate additional site data when available.



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## **Appendices**

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Appendix B - Tables

Appendix C - Arsenic MCL Revision History

Appendix D - Exposure Assumptions

Appendix E - Public Health Hazard Conclusion Categories

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## **Appendix B - Tables**

Table 1 - Contaminants of Concern in Private Wells

Table 2 - Contaminants of Concern in Public Wells

Table 3 - Range of Contaminant Concentrations (ppb) in on-site Monitoring Wells.

<b>Table 1.</b> Maximum concentrations of contaminants of concern in private wells within 1-mile radius of the B&L Site located in Pierce County, WA. <sup>a</sup>				
Contaminant	Concentration (ppb)	Location	Carcinogenic Comparison Value (ppb)	Non-carcinogenic Comparison Value (ppb)
Antimony	25.0U	Multiple wells	None	4 (Child RMEG)
Arsenic (inorganic)	31.0	*Well #29	0.02 (CREG)	3 (Child Chronic EMEG)
Cadmium	4.0U	Multiple wells	None	2 (Child Chronic EMEG)
Copper	24.0	Well #28-h	None	200 (SRL)
Lead	6.3	Well #12	None	2 (SRL)
Mercury (inorganic)	0.2U	Multiple wells	None	2 (Lifetime Health Advisory)

a = Samples collected in 1987, 1992, and 2000.

<b>Table 2.</b> Maximum concentrations of contaminants of concern in municipal wells within 1-mile radius of B&L Site located in Pierce County, WA.				
Contaminant	Concentration (ppb)	Location/ Date	Carcinogenic Comparison Value (ppb)	Non-carcinogenic Comparison Value (ppb)
Antimony	<2.0	Multiple	None	4 (Child RMEG)
Arsenic (inorganic)	21.0	CF #3/2000	0.02 (CREG)	3 (Child Chronic EMEG)
Cadmium	<2.0	Multiple	None	2 (Child Chronic EMEG)
Copper <sup>a</sup>	<10	Multiple	None	200 (SRL)
Lead <sup>b</sup>	17.0	CF #5/1989	None	2 (SRL)
Mercury (inorganic)	<1.0	Multiple	None	2 (Lifetime Health Advisory)

a = Some detections limits for copper exceeded 10 ppb.

b = Lead was not detected in any other municipal well samples.

<b>Table 3. Range of contaminant concentrations (ppb) in on-site monitoring wells at the B&amp;L site located in Pierce County, WA.</b>						
Well Location	Antimony (ppb)	Arsenic	Cadmium	Lead	Screen Depth (feet)	Date Constructed
D-1U	None	<5-29	None	2-50	8-13	9/89
D-1L	None	7-24	0.7	2-23	25-30	9/89
D-3U	10	<5-23	0.3	2-20	7.5-12.5	8/89
D-3L	None	<5-20	None	2-20	19-24	8/89
D-4U	5	<5-20	None	2-20	8-13	8/89
D-4L	None	<5-20	None	2-20	18-23	8/89
D-5U	None	22-480	None	2-20	8.5-13.5	7/90
D-5L	None	<5-20	None	2-20	25-30	7/90
D-6A	None	14-3,252	None	2-21	10-15	10/93
D-6B	None	<5-6	None	2-5	28-33	10/93
D-7A	None	<5-6	None	2-7	9.5-14.5	10/93
D-7B	None	<5-9	None	2-9	28-33	10/93
D-8A	None	69-270	None	2-5	10-15	11/93
D-8B	None	24-790	None	2-7	28-33	11/93
D-9A	None	34-84	None	2-11	8.5-13.5	11/93
D-10A	None	220-542	None	2-9	10-15	11/93
D-11A	None	<5-39	None	2-21	10-15	11/93
D-11B	None	<5-7	None	2-9	25-30	11/93
MW-13	None	4300-6200	None	3-27	9.5-14.5	9/98
MW-14	None	<5-16	None	5-17	10-15	9/98
MW-15	None	2300-3400	None	3-5	10-15	9/98
MW-16	None	<5	None	3-5	10-15	9/98
MW-17	None	<5	None	3-8	10-15	9/98

## **Appendix C - Arsenic Drinking Water Standard (MCL) Revision History**

An Maximum Contaminant Level (MCL) of 50 parts per billion (ppb) inorganic arsenic in drinking water was set by the U.S. Environmental Protection Agency (EPA) in 1975. This MCL was based upon a Public Health Service standard established in 1942.<sup>12</sup> The 1996 amendments to the Safe Drinking Water Act required EPA to promulgate a final rule (for the arsenic drinking water standard) by January 1, 2001. In 1996, EPA requested that the National Research Council (NRC) review and provide comment on research related to arsenic toxicity so EPA would have an unbiased state-of-the-science evaluation upon which to base a final MCL for arsenic in drinking water.

The NRC Subcommittee on Arsenic in Drinking Water published its evaluation in May 1999 and stated that “it is the subcommittees’ consensus that the current EPA MCL for arsenic in drinking water of 50 µg/L does not achieve EPA’s goal for public health protection and therefore required a downward revision as promptly as possible.” Based in part on the NRC recommendation, on January 22, 2001, the EPA published a final rule that lowered the enforceable MCL for arsenic in community water systems from 50 to 10 µg/L (micrograms per liter). On January 31, 2001, a Bill was introduced in the United States Senate to void the final arsenic rule and keep the MCL at 50 micrograms per liter. To date, the Senate Bill is still pending.

Due to concerns of increased cost (an MCL is not strictly health-based, but must consider costs of compliance), this lower MCL was rescinded while further study is conducted. It should be noted that the arsenic dose at the MCL is close to the dose where health effects have been observed in people; there is less than 10-fold difference. In contrast, the MCLs for most other cancer-causing chemicals are set 2,000 to 870,000 fold less than the doses found to cause health effects. Because of the reliance on cost and the low margin of safety for the arsenic MCL, it may not be the best reference value to evaluate the arsenic health hazard at the B&L site.

If the drinking water standard (MCL) of 10 micrograms per liter remains valid, public water systems serving at least 25 of the same individuals for more than six months per year, would be required to notify drinking water consumers if the arsenic levels in their drinking water exceed the new drinking water standard of 10 ppb. The drinking water standard for arsenic is intended to protect consumers against the effects of long-term chronic exposure to arsenic in drinking water.



## Appendix D - Exposure Assumptions

A residential child exposure scenario was evaluated for the B&L Landfill site. A central tendency and upper bound exposure scenario were evaluated.

The following formula was used to calculate an ingestion exposure dose:

$$\text{Ingestion Exposure Dose} = [(C \times IR \times EF \times ED) / (BW \times AT)]$$

C = Concentration of contaminant in water (ug/l) = 31

IR = Drinking Water Ingestion Rate (liters per day)

Child (0-5 years) = 0.9 liters per day mean/1.5 liters per day upper bound

Young adult (6-15 years) = 1.0 liter per day mean/1.7 liters per day upper bound

Adult (16 years or older) = 2 liters per day mean/2.3 liters per day upper bound

EF = Exposure Frequency (day/year) = 350

ED = Exposure Duration (total # of years in exposure period) = 30

BW = Body Weight (kg)

Child (0-5 years) = 16 kg

Young adult (6-15 years) = 40 kg

Adult (16 years or older) = 70kg

AT = Averaging Time (days)

In the case of exposure to carcinogens the averaging time is assumed to be 70 years x 365 days/year. For non-carcinogens, the averaging time is the actual length of the exposure period.

**Cancer Risk** (upper-bound) = 9 E-04

**Cancer Risk** (central tendency) = 7 E-04

## Appendix E - Public Health Hazard Conclusion Categories

Category	Definition
1. Urgent Public Health Hazard	This category is used for sites where short-term exposures (<1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.
2. Public Health Hazard	This category is used for sites that pose a public health hazard due to the existence of long-term exposures (>1 yr) to hazardous substances or conditions that could result in adverse health effects.
3. Indeterminate Public Health Hazard	This category is used to sites in which “critical” data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.
4. No Apparent Public Health Hazard	The category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.
5. No Public Health Hazard	This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.

## **Certification**

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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